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CENTRAL INTELLIGENCE AGENCY

INFORMATION REPORT

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SUPPLEMENT TO REPORT NO.

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THIS IS UNEVALUATED INFORMATION

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Attached is forwarded as received.

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Comment: Dickel's superiors, to whom reference is made in the attached report, were Dipl. Ing. Max Lorenzen and Dr. Gerhard Cordes.

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COUNTRY USSR REPORT

TOPIC Development Activities at Experimental Plant No 2 in Upravlencheski 25X1

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EVALUATION PLACE OBTAINED 25X1

DATE OF CONTENT 25X1

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REFERENCES

PAGES 5 ENCLOSURES (NO. & TYPE) 2 - two blueprints

REMARKS

This is UNEVALUATED Information 25X1

1. The P-130 was a supercharged Diesel engine, the development of which had been started in Dessau and was continued at Upravlencheski. The unit was about equal in weight to the TL-012 turbojet engine. In late 1947, this uncompleted project was cancelled. 1

2. The TL-004 turbojet engine was rebuilt from original parts which had been brought from Dessau or from Soviet-built copies. The test runs with this engine were discontinued in late 1947. An exhaust jet turbine which was developed and built on the basis of the TL-004 was used for the testing of compressor stages until late 1953.

3. The TL-012 engine had a static thrust of 3,000 kgp. No details were remembered. The TL-012 F, a version with an entirely new set of blades, was cancelled for undetermined reasons during the development in mid-1949.

4. The GT-30 heavy stationary gas turbine, rating at 30,000 hp, had an air flow rate of about 300 kg/sec and blades more than 0.5 meters long. The unit was designed by Ing Gassenmeier (fnu). It was rumored, however, that the turbine had been ordered and was received in late 1950. The GT-30 was to be used to drive the emergency power generators. 25X1 25X1

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5. PTL-022, Series A turboprop engine. The first version was equipped with a 14-stage axial-flow compressor, a 3-stage turbine and two 4-bladed counter rotating propellers, 4.8 m in diameter.

The effective output: 5,800 to 6,000 hp shaft and thrust power at 7,800 rpm

The specific fuel consumption: 380 g/hp/h and more.

The compression ration: 6.3 [2]

Mach number in the compressor: 0.8

Maximum temperature between combustion chambers and turbine T_4 -980 to 1,000 degrees Kelvin's scale.

The turbine blades were made of an 85 percent cobalt alloy. [3]

The ration of width of turbine blade (B) to the maximum diameter (D) of the turbine wheel: B/D - 8 percent.

Power ration: a ≈ 0.4

6. The second version of the PTL-022 had a different compressor blade profile which effected an increase in compression from 6.3 to 7 and also a reduction of the specific fuel consumption to 250 g/hp/h. The method to be applied to improve the PTL-022 was heatedly argued between Dr Ing Cordes and Hans Dickel. After one year of vain efforts in solving the problem by increasing the mass of the compressor, Dr Cordes finally accepted the system suggested by Dickel in July 1949 which was based on the following theory: The conventional steam turbine type profiles were too long for compressor blades. To a certain degree the compressor ran idle, and consequently the desired pressure was not obtained. After leaving the smallest flow section of a compressor stage, i.e. at the "slanting" (sic) part of the compressor blades, the flow broke away from the blades and effected shocks on the next compressor stage. In order to eliminate these expansion strokes, the flow section through the compressor had to be modified. Dickel, an expert for aerodynamics, replaced the long parallel running "tail" of the steam turbine type blades with some sort of wing-type profiles. Under other unchanged conditions the mere modification of compressor blade profiles effected an increase of compression from 6.3 to 7. [4] As represented in the following formula the efficiency of the turbine, factor η, was increased from 85 to 92.5 percent.

$$\eta = \frac{H^*_{eff}}{H^*_{ad}} = \frac{T^*_4 - T^*_6}{T_{6_{ad}} + T(e_6)^2_{stat}}$$

This simultaneously effected an SFC reduction from 380 g/hp/h to 250 g/hp/h. Dickel believed that it would be possible to obtain the optimum values in precise theoretical and experimental research work, which he expected would result in a further increase of compression and in an additional reduction of the specific fuel consumption.

7. The first Soviet reaction to this sensational improvement was rather negative, and a commission was ordered to detect the alleged swindle involved. Although the Soviets were amazed when the data given were checked, they still continued to critize the accomplishments and requested further improvements.

8. The German experts consequently developed the third version of the PTL-022 turboprop engine, equipped with so-called "Staffkis" in the external compressor coat and with "labyrinths" in the turbine unit. Staffkis were small plates made of crucible graphite and provided with dovetails. In order to reduce the losses caused by the separation of the flow at the tips of the rotor blades the "Staffkis" were inserted in the compressor casing.

The engine was to be started very carefully so that the rotor blades would slowly grind these plates into shape, effecting a minimum clearance between rotor blades and casing, i.e. at normal rating of about 0.3 to 0.5 mm. [5] When the graphite stocks were exhausted, copper proved useful for this purpose; aluminum was found unfit. [6] The so-called labyrinth, a serration between stator and rotor units in the turbine, effected a reduction of losses caused by the flow about the blades. [7] An additional improvement was achieved by modifying the shape of the combustion chambers which directed the main gas flow to the center part of the turbine blades where maximum pressure and maximum efficiency was expected. This made the outer part of the blades cooler. No information was obtained on the layout and shape and dimensions of the combustion chambers.

9. Series E of the PTL-022 and series E/D were development stages for the PTL-022 K. [8]

10. PTL-022 M was a dual engine composed of two A-022 units driving two counterrotating propellers over one gear unit. The total output was 12,000 hp. For the flight tests, Experimental Plant No 2 had developed and constructed a tail pipe 5 meters long. This exhaust gas pipe, elliptic in section at the front end, tapered to the rear where it ended in a circular section, 0.8 m in diameter. The pipe followed in shape exactly the profile of the upper side of the wing.

11. PTL-022 K was an improved version of the PTL-022 M. The power unit was equipped with a 14-stage axial-flow compressor, a 5-stage turbine and was designed for an altitude of 13,000 meters. Two such engines combined to a double engine were to drive over one gear unit two 5-bladed counterrotating propellers with a diameter of 5.5 meters. [9] These propellers were probably identical to the ones used for the PTL-022 M. It was unknown where these propellers were produced. The engine data included:

Combined shaft and thrust power: 12,000 hp at 7,250 rpm

SFC per single engine: 185 g/hp/h [10]

Compression ratio: 7

Mach number in compressor: M - 0.8

Pressure aft of the compressor: Pm - 7.5 atmospheres

Maximum temperature between combustion chambers and turbine: T_4 - 1,150 degrees Kelvin's scale

Pressure at the turbine entrance: p_4 - 7.3 atmospheres

The turbine blades were solid, no cooling, and made of 85 percent cobalt alloy

Ratio width of turbine blade B to maximum diameter of the turbine wheel D: B/D - 7.8 percent

Another innovation was a third bearing of the shaft aft of the turbine

Power ratio: a ~ 0.45.

12. In late 1952 experiments were initiated to increase the temperature of reaction from 1,150 to 1,400 degrees Kelvin scale. The two methods applied included:

a. The use of solid ceramic blades which were received from the TSIAM VIAM Plants. No information was obtained of the material used and on the plant actually producing these blades. They were white and were "probably made of Al-oxides". [11] It was learned that these blades were to be used in the first and perhaps also in the second turbine stage. No information was obtained on the experiments.

b. The development of hollow blades and hollow turbine discs: Cooling was to be effected by branching off air from the compressor. Detailed calculations were conducted on heat conditions in hollow bodies.

13. In spite of all the efforts made during the experiments, it was not possible to obtain an exact definition of the temperature of reaction T_4 between combustion chambers and turbine. The figures obtained varied up to 500 degrees Kelvin. The measurements were made with thermo elements.

14. Experiments had failed to increase the Mach number in the 14-stage compressor from M - 0.8 to M - 1.1 to 1.3. The special "ultra sound stages" by the TSIAM Plant proved to be inadequate. No further information was obtained on the layout of these ultra sound stages or the causes of the failure. In about late 1952, the experiments were continued by Soviet experts for Project K which, at that time, was still at the test stands.

Flight Tests

15. Both versions of the PTL-022, the A and the M, were successfully tested by the government. The state test was made in the vicinity of Moscow and no German experts were present. It was not exactly remembered when these state tests took place. In mid-1952 two complete units had to be delivered to Moscow where they were successfully test flown. Rumors heard among the Germans in Upravlencheski indicated that the power units were installed in Soviet built B-29 bombers for the test flights and that German experts from Experimental Plant No 1 in Podberezhe were present. A starter unit was the only spare part delivered.

Series Production

16. It was rumored that the TL-004 turbojet engine was series produced at the Bezymyanka Plant and in Ufa. In mid-1949, the Soviet chief Kuznetsov (fnu) arrived from Ufa to replace Olekhnovich (fnu). The Bezymyanka Plant was primarily involved in the production of the British Nene centrifugal flow turbojet engine.

17. After the PTL-022 A and the PTL-022 M had passed the state test, construction drawings had to be prepared for the Bezymyanka Plant and for the Mechanical Saved both located in Kuibyshev. The Soviet requested simplifications for the production process which, among others, included a larger axial play at the bearings. Parts produced by the aforementioned plants were sent to Experimental Plant No 2 for exact gauging. It was believed that this was done in order to give further directions to the producing plants. According to these parts, the Soviets were not capable of keeping to the tolerances of the power plants constructed by the German experts at Experimental Plant No 2. [redacted] 25X1 25X1 the Soviet built engines were about 40 percent heavier and that their SFC rating was about 30 g/hp/h higher.

18. In addition to the production problems, there were difficulties involved in the supply of raw material. The quality of the raw material received at Experimental Plant No 2 varied widely and single parts such as ball bearings, pumps etc were below German standards.

19. The thrust of the PTL-022 was allegedly less than 10 percent of the total power. The speed of the residual exhaust gases was c_b - 200 to 250 m/sec.

20. Kerosene was used as fuel. No information was obtained on the purity of the fuel which appeared to contain much tar. The combustion efficiency was 98 to 98.5 percent, which indicated that [redacted] was totally burned. The designing of the compressor was based on the assumption that the figure λ - 4, i.e. the quantity of air fed to the unit was four times as high as theoretically needed for the complete burning of the fuel.

21. The annular combustion chambers of the PTL-022 were made of Cr-Ni also E 81 T which was said to be equal in quality to the American "Nimonik". The walls of the combustion chambers were 1 to 1.5 mm thick.

22. Roots type compressors were used as starter units.

23. Concerning the endurance, it was stated that the power units were to stand 100 hours of operation, but 200 hours were expected and actually reached in most cases. Continuous test runs of the power units proved that the gears were the first part to become defective and that the blades would then show cracks. However, small quenching cracks on the blades which usually occurred as a result of 100 hours of operation, hardly affected the performance of the engine. In individual cases, the lifetime did not exceed five hours. This was a result of the poor quality of material received from the VIAM and TSIAM Plants.

24. The PTL-022 gear unit was designed by Soviet engineers. However, when the reduction gear of the PTL-022 A disintegrated during the test run, the gear unit was redesigned by Ing Richard Elze.

25. In the fall of 1953 an undetermined number of new test stands were completed. These test stands were constructed after models of the Otto Mader Werk in Dessau. The Soviets requested that high altitude tests be conducted at the test stands in Upravlencheski Although there were no low-pressure chambers available, Dr Cordes accepted this order hoping to solve the problem by taking the equivalent for high altitudes of the pertinent ground figures and by applying an increased load or probably by eliminating one or more stages. The experiments however had to be cancelled. 12

1. [redacted] Comment. The P-130 Diesel engine is reported for the first time. 25X1

2. [redacted] Comment. Most previous sources reported the first version of the PTL-022 A with a compression ratio of 4.5 to 4.8.

3 [redacted] Comment. An 85-percent cobalt alloy is believed to be improbable. More credible information indicated that experiments were conducted with a 55 percent cobalt alloy. 25X1

4. [redacted] Comment. For sketch of the blade profile, see Annex 1 . 25X1

5. [redacted] Comment. [redacted] graphite rings into which the blades were to grind their way were used. 25X1

6. [redacted] Comment. It is believed improbable that the blades could grind a path into copper. 25X1

7. [redacted] Comment. The arrangement of the "labyrinths" is not clear. 25X1

8. [redacted] Comment. Series E is reported for the first time. According to previous information, the D series was the last development, which involved a version of the PTL-022 K for high altitude flights.

9. [redacted] Comment. According to concordant information obtained from the other sources, the PTL-022 K is a single power unit driving four-bladed counterrotating propellers. 25X1

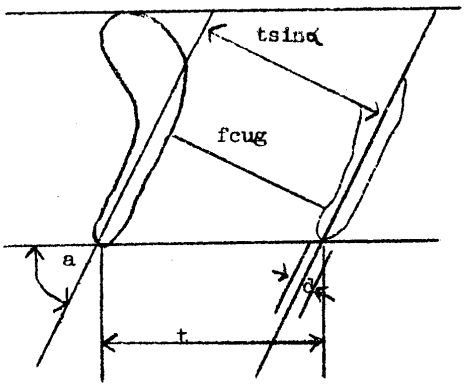
10. [redacted] Comment. A specific fuel consumption of 185 g/hp/h seems to be improbable. [redacted] 25X1 25X1

11. [redacted] Comment. According to previous information, no results were obtained in experiments with ceramic blades for the PTL-022. [redacted] ceramic blades were only used theoretically. 25X1 25X1 25X1

12. [redacted] Comment. For a chart of activities at Experimental Plant No 2 in Upravlencheski, see Annex 2. 25X1

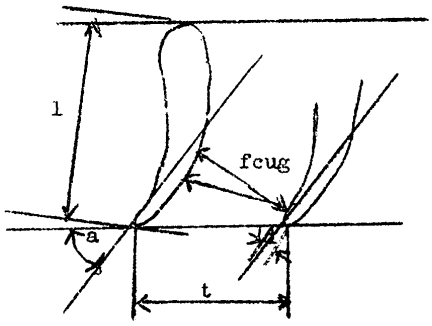
[redacted] 25X1

Old and New Profiles of Rotor Blades in the Compressor Unit of an A-022 Turbo-prop Engine



Old profile with parallel trailing edges

fcug = tsinα - d



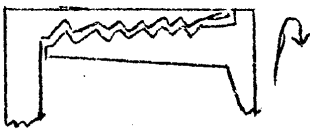
New wing-shaped profile

fcug = tsina

$\frac{t}{l_{stator}}$ = 0,55 - 0,65

$\frac{t}{l_{rotor}}$ = 0,65 - 0,75

The length of the blades (l) and the pitch (t) are reduced.



Labyrinth

Activities Turbine and Exhaust Components

Annex 2

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	1946	1947	1948	1949	1950	1951	1952	1953
Period	22 October						July 1952	November 53
Location	Dessau	Upravlencheskij near Kuybyshev						
Soviets Chiefs	Olekhnovitch			Kusnetsov				
Chief Designers	Dr Scheibe		1. Brander 2. Dr Scheibe		Dr Scheibe (took little part)			
Department Chiefs	Lorenzen		Dr. Cordes					
P-130	development of turbo-compressor (1)							
TL-004	redesigning and test runs (2)							
Exhaust Gas Turbine	Development and construction	continuous testing activities for compressor stages						
TL-012	new type of blades evaluation of testing data							
TL-012 F	new blade profiles (3)							
GT-30	advising on partial designs							
PTL-022 A	designing and construction activities	test runs	ne w blade profiles					

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Activities of Turbine and Exhaust Components

Annex 2

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Period	1946	1947	1948	1949	1950	1951	1952	1953
	22 October						July 1952	[redacted]
PTL-022 M						construction	turned over to construction department	
Roots-Starter						designing and construction		
PTL-022 E/D						further development and basic work for type K		
Project K						ceramic and hollow blades		turned over to Soviet development
Exhaust gas turbine based on 022								development and construction activities (4)

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(1) was discontinued during the development

(2) temporarily discontinued during development

(3) turned over to Soviet production

(4) departure of German group